APPRENTICESHIP TRAINING

Boilermaker Program

Alberta
LEARNING
Apprenticeship and Industry Training

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Boilermaker

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Course Outline

Apprenticeship and Industry Training System

Apprenticeship is post-secondary education with a difference. It helps ensure Alberta has a steady supply of highly-skilled employees, the foundation of our economy's future health and competitiveness.

Apprentices in more than 50 trades and crafts spend between one and four years learning their trade - 80% of the time on the job under the supervision of a certified journeyman or qualified tradesperson. The balance of the program is technical training in the theory, skills and technologies of their trade.

To become certified journeymen apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board (the Board) and a network of local and provincial industry committees.

The graduate of the Boilermaker apprenticeship training is a journeyman who will be able to:

- understand the principles of drafting; how drawings originate, their purpose and how to correctly interpret the information therein.
- understand the use of each type of drawing, part work order sketches, materials lists and specification sheets.
- layout from drawings to material; pattern development and template making.
- relate to all applicable Codes and Regulations with reference to materials specifications, uses and safety for vessels of all types and the acceptable methods of construction for pressure vessels.
- relate to metallurgy, structural shapes, plate, pipe and pipe fittings with respect to vessel components, ropes, wire and fibre types, uses of pipe and its respective fittings and materials used with pressure vessels, both metallic and non-metallic.
- use hand tools and powered equipment in a proper and safe manner.
- calculate material quantities.
- perform a satisfactory operation with oxyfuel or electric arc welding equipment in order to facilitate this work.
- relate to the work of other tradesmen in affiliated trades.

Apprenticeship and Industry Training Committee Structure

While government supports Alberta's apprenticeship and industry training system, it is driven by industry, a term which includes both employers and employees. The Alberta Apprenticeship and Industry Training Board, with the support of Alberta Learning, oversees the system. But the system relies on a network of industry committees. These committees include local and provincial apprenticeship committees (LACs and PACs) in the designated trades and occupational committees (OCs) in the designated occupations, as well as other committees such as provisional committees established before the designation of a new trade or occupation comes into effect. All these committees are composed of equal numbers of employers and employees. The network of industry committees is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the Board can set up a LAC. The Board appoints equal numbers of employees and employers for terms of up to three years. The committee appoints a member as presiding officer. Local Apprenticeship Committees:

- monitor the apprenticeship system, and the progress of apprentices in their trade, at the local level.
- help settle certain kinds of issues between apprentices and their employers.
- recommend improvements in apprenticeship training and certification to their trade's provincial apprenticeship committee.
- make recommendations to the Board regarding the appointment of members to their trade's PAC.

Provincial Apprenticeship Committees (PAC)

The Board establishes a PAC for each trade and, based on PAC recommendations, appoints a presiding officer and equal numbers of employees and employers for terms of up to three years. Most PACs have nine members. Provincial Apprenticeship Committees:

- identify the training needs and content for their trade.
- recommend to the Board the standards for training and certification for their trade.
- monitor the activities of local apprenticeship committees in their trade.
- make recommendations to the Board about the designation of trades and occupations.
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in the trade.
- may participate in resolving any apprenticeship-related disputes between employers and employees.

Boilermaker PAC Members

Mr. C. Booth	Edmonton	Presiding Officer
Mr. N. Kolebaba	Calgary	Employer
Mr. G. Jacobs	Edmonton	Employer
Mr. R. Labossiere	Edmonton	Employer
Mr. M. Collier	Medicine Hat	Employer
Mr. A. Linklater	Calgary	Employee
Mr. G. Donnelly	Edmonton	Employee
Mr. R. Ewasiuk	Edmonton	Employee
Mr. C. McEwen	Edmonton	Employee

The Alberta Apprenticeship and Industry Training Board (Board)

The mandate of the Alberta Apprenticeship and Industry Training Board relates to the standards and requirements for training and certification in programs under the *Apprenticeship and Industry Training Act*. The Board provides advice to the Minister of Learning on the training and certification of people in designated trades and occupations and on the needs of the Alberta labour market for skilled and trained persons. The Board also makes orders and regulations respecting standards and requirements for apprenticeship programs and the training of apprentices and for training and certification in designated trades and occupations, and the criteria or requirements for granting and recognizing trade and other certificates.

The 13-member Board consists of a chair, eight members representing trades and four members representing other industries. The trades and other industry members are equally represented by employer and employee representatives.

Safety Education

Safe working procedures and conditions, accident prevention and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees and the public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and environments can be created by controlling the variables and behaviours that may contribute to or cause an accident or injury.

It is generally recognized that a safe attitude contributes to an accident free environment. Everyone will benefit as a result of a healthy, safe attitude towards prevention of accidents.

A tradesperson is possibly exposed to more hazards than any other person in the work force and, therefore, should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code dealing with personal safety and the special safety rules applying to each task.

Legal and Administrative Aspects of Safety

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer and employee.

Employer's Responsibilities

The employer is responsible for:

- providing and maintaining safety equipment and protective devices.
- ensuring proper safe work clothing is worn.
- enforcing safe working procedures.
- providing safeguards for machinery, equipment and tools.
- observing all accident prevention regulations.
- training employees in the safe use and operation of equipment.

Employee's Responsibilities

The employee is responsible for:

- working in accordance with the safety regulations pertaining to the job environment.
- working in such a way as not to endanger themselves or fellow employees.

Workplace Health and Safety's Responsibilities:

Workplace Health and Safety (Alberta Human Resources and Employment) will conduct periodic inspections of the workplace to ensure that safety regulations for industry are being observed.

Technical Training Establishment

Alberta Learning, Apprenticeship and Industry Training offer your apprenticeship training program. Staff and facilities for delivering the program are supplied by the Northern Alberta Institute of Technology at Souch campus

Procedures For Recommending
Revisions To The Course Outline

Apprenticeship and Industry Training, Industry Programs and Standards has prepared this course outline in partnership with the Boilermaker Provincial Apprenticeship Committee.

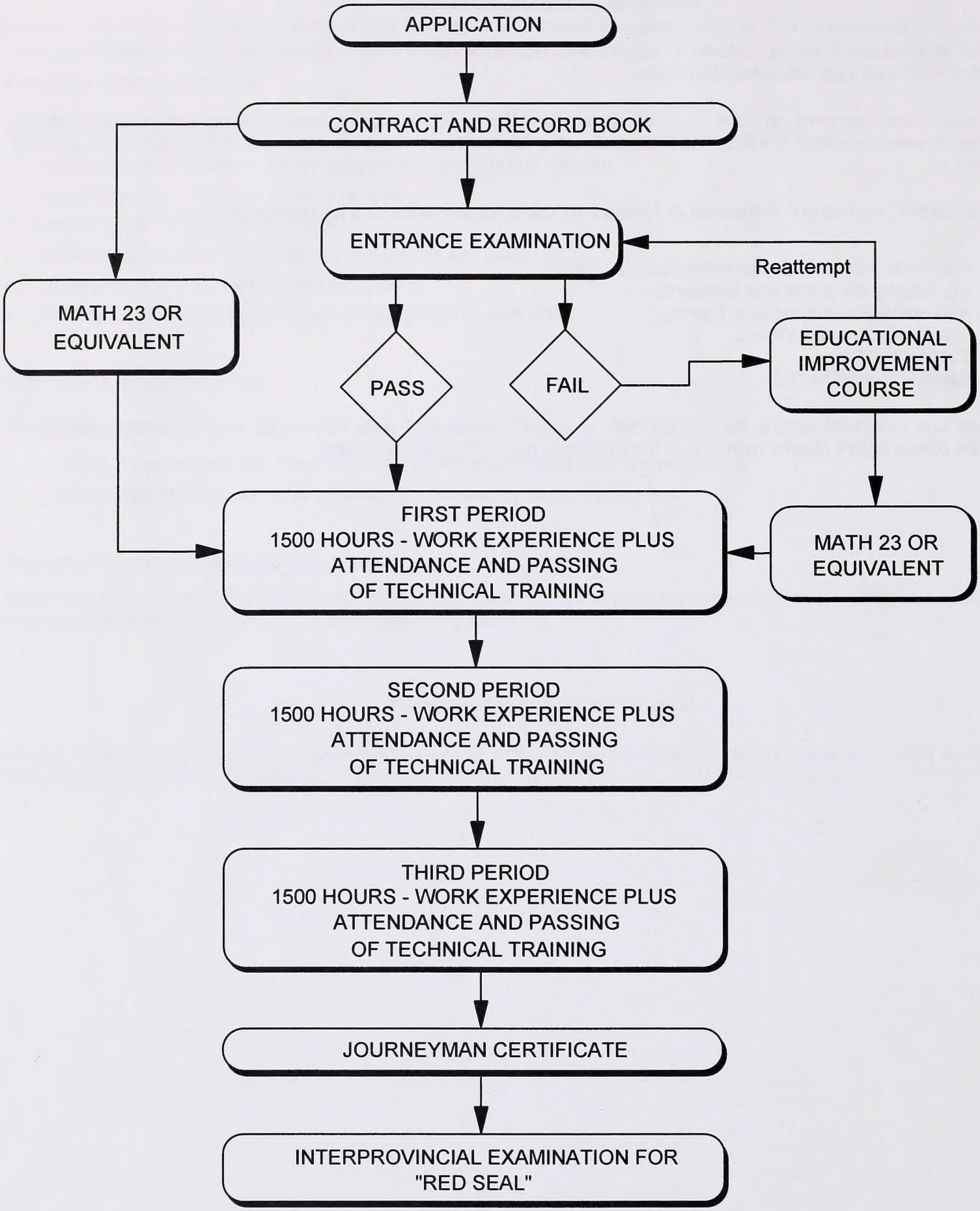
This course outline was approved on June 27, 2003 under the authority of the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. Valuable input is acknowledged from industry and the institutions.

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to:

Boilermaker Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
10th floor, Commerce Place
10155 - 102 Street
Edmonton, AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

Apprenticeship Route Toward Certification



Boilermaker Training Profile

Entry Level

(6 Weeks 30 Hours Per Week – Total of 180 Hours)

SECTION ONE

GENERAL SAFETY — **38 Hours**

A	B	C
Common Hazards — 14 Hours	Proper Use of Safety Equipment — 3 Hours	Workers' Compensation Board — 1 Hour
D	**E**	**F**
Related Knowledge — 6 Hours	Emergency First Aid and C.P.R. — 8 Hours	Mathematics — 6 Hours

SECTION TWO

BASIC RIGGING — **36 Hours**

A	B	C
Ropes — 28 Hours	Lifting Devices — 4 Hours	Signals — 4 Hours

SECTION THREE

TOOLS, CUTTING AND WELDING — **62 Hours**

A	B	C
Tools — 22 Hours	Flame Cutting — 20 Hours	Electric Arc Welding — 20 Hours

SECTION FOUR

MATERIALS KNOWLEDGE — **44 Hours**

A	B	C
Metallurgy — 8 Hours	Basic Materials — 20 Hours	Trade Related Components — 16 Hours

FIRST PERIOD

(10 Weeks 30 Hours Per Week – Total of 300 Hours)

SECTION ONE

TOOLS, CUTTING AND WELDING — **64 Hours**

A	B	C
Instruments — 4 Hours	Power Tools (Electric and Pneumatic) — 6 Hours	Shop Equipment — 8 Hours
D	**E**	
Metallurgy — 14 Hours	Cutting, Welding and Related Processes — 32 Hours	

SECTION TWO

DRAWING INTERPRETATION — **84 Hours**

A	B	C
Basic Drafting — 27 Hours	Identification of Pressure Vessels — 7 Hours	Introduction to Layout — 18 Hours
D	**E**	
Materials Preparation and Assembly — 12 Hours	Basic Mathematics — 20 Hours	

SECTION THREE

GENERAL RIGGING — **32 Hours**

A	B
Wire Rope — 12 Hours	Block and Tackle — 20 Hours

SECOND PERIOD
(10 Weeks 30 Hours Per Week – Total of 300 Hours)

SECTION ONE

MATERIALS AND RELATED KNOWLEDGE — **30 Hours**

- **A** — Heat Treatment — 10 Hours
- **B** — Related Knowledge — 20 Hours

SECTION TWO

ADVANCED RIGGING — **52 Hours**

- **A** — Wire Rope Drums — 4 Hours
- **B** — Advanced Block and Tackle — 12 Hours
- **C** — Gin Poles — 2 Hours
- **D** — Cranes — 12 Hours
- **E** — Stiff Leg and Guy Derricks — 2 Hours
- **F** — Hoisting and Jacking Equipment — 10 Hours
- **G** — Scaffolds — 8 Hours
- **H** — Rigging Prints — 2 Hours

SECTION THREE

LAYOUT AND FITTING — **98 Hours**

- **A** — Mathematics — 18 Hours
- **B** — Drawing Interpretation — 24 Hours
- **C** — Layout and Fabricating — 30 Hours
- **D** — Fibreglass Fitting — 26 Hours

THIRD PERIOD
(10 Weeks 30 Hours Per Week – Total of 240 Hours)

SECTION ONE

MATERIALS AND RELATED KNOWLEDGE — **30 Hours**

- **A** — Testing of Materials — 10 Hours
- **B** — Inspection — 20 Hours

SECTION TWO

LAYOUT AND FITTING — **50 Hours**

- **A** — Layout — 30 Hours
- **B** — Fitting — 20 Hours

SECTION THREE

TRADE RELATED COMPONENTS — **100 Hours**

- **A** — Boilers — 30 Hours
- **B** — Tanks — 30 Hours
- **C** — Condensers and Exchangers — 30 Hours
- **D** — Introduction to Other Heavy Industry — 10 Hours

NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training

ENTRY LEVEL TECHNICAL TRAINING
BOILERMAKER TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS COURSE THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: .....GENERAL SAFETY..... 38 HOURS

This section presents information on accident prevention, first aid, the operation of fire fighting equipment and Workplace Hazardous Material Information System (W.H.M.I.S.).

The safety subject matter taught in this section must also be stressed in the appropriate sections throughout the Boilermaker training program.

A. Common Hazards..... 14 Hours

1. Identify potential fatal hazards in confined space entry:
   a) entering without testing
   b) lack of retesting
   c) not blanking or locking out
   d) lack of ventilation
   e) inert gases
   f) use of oxygen
   g) cutting /welding hoses and valves
   h) welding without checking neighbouring compartments
   i) sludge in confined space
   j) lack of respiratory protection
   k) possible toxic or flammable material
   l) improper rescue procedures.

2. Locate and identify legislation and regulations pertinent to "confined space entry":
   a) definition of confined space
   b) employer's responsibilities
   c) employee's responsibilities
   d) code of practice for entry and work in confined spaces
   e) safety training.

3. Describe the following hazards in confined space entry:
   a) enclosed spaces
   b) partially enclosed spaces
   c) natural ventilation
   d) oxygen deficiency
   e) explosive and toxic liquids and gases
      i) hydrogen sulfide
      ii) carbon monoxide
      iii) liquid materials
   f) decaying organic matter in confined space
   g) fire triangle
   h) lower and upper explosive limits.

4. Preplan confined space entry:
   a) atmospheric testing and monitoring
   b) procedures
   c) preparations
   d) safety equipment and clothing
   e) ground fault interrupters
   f) explosion proof lighting
   g) rescue equipment.

5. Identify and describe a permit system for confined space entry.

6. Introduction to W.H.M.I.S. (Workplace Hazardous Materials Information System)
   a) Describe what W.H.M.I.S. is, its rational and major elements.
   b) Define what is meant by a W.H.M.I.S. label and distinguish between supplier and workplace labels and other means of identification.
   c) Describe what is meant by the following classifications:
      i) prohibited product
      ii) restricted product
      iii) controlled product.
   d) Explain what a Material Safety Data Sheet (M.S.D.S.) is, its purpose and limitations.
   e) Describe the roles and responsibilities of employer, supplier and worker in the education of workers.
   f) other subject areas as deemed appropriate and deliverable by the training establishments.

7. Identify other hazards
   a) Recognize and correct common causes of accidents in the work environment.
   b) Carry out work activities in a manner conductive to a maximum possible standard of shop safety.
   d) Recognize, report and/or eliminate fire hazards existing in the work environment.
   e) Recognize various classes of fires and be aware of the extinguishing medium for use in each case.
   f) Effectively operate fire-extinguishing equipment to extinguish various classes of fires.
   g) Demonstrate knowledge of the fall restraint, fall arrest program.

B. Proper Use of Safety Equipment..... 3 Hours

1. Demonstrate the proper use of the following safety equipment:
   a) welding helmets
   b) boots
   c) glasses
   d) goggles/shields
   e) safety harness
   f) clothing
   g) dust filters / respirators
   h) fresh air breathing equipment
   i) air movers
   j) safety showers / eyewash stations
   k) fire fighting equipment
   l) hearing protection equipment
   m) head protection.

2. Identify safety features incorporated on various pieces of equipment.

C. Workers' Compensation Board (W.C.B.)..... 1 Hour

It is understood that the W.C.B. is a generic term referring to the provincial governing authority.

1. Complete and remit the appropriate forms as may be required by the W.C.B.:
   a) form to be completed
   b) methods of completing
   c) where to remit.

2. Interpret Workers' Compensation Board regulations.

D. Related Knowledge..... 6 Hours

1. Recognize and assess the responsibilities to:
   a) oneself
   b) the public
   c) fellow workers
   d) supervisory personnel (foreman and employer)
   e) work opportunities

f) provincial government departments
g) the unions.

2. Determine good public relations with other trades as well as problems and public needs:
   a) cooperation with allied trades
   b) coordination with other trade functions
   c) recognition of problems in all phases
   d) consideration of public needs.

3. Apprenticeship orientation
   a) Describe the apprenticeship training system in Alberta.
   b) Identify the training profile of a Boilermaker Apprentice in Alberta.
   c) Describe the responsibilities for the Contract of Apprenticeship by the apprentice, employer and Alberta Apprenticeship and Industry Training.
   d) Discuss the contents of the apprenticeship training Record Book.

E. Emergency First Aid and C.P.R. ..... 8 Hours

Administer immediate on the spot first aid to persons with minor injuries and administer temporary emergency first aid to the more seriously injured, as deemed adequate until qualified medical personnel are available.

1. Explain the responsibilities and duties of the first aid person.

2. Explain the diagnoses for:
   a) respiratory failure
   b) burns
   c) body injury.

3. Applying artificial respiration
   a) Explain the process of freeing the victim of breathing restrictions.
   b) Explain the process of applying mouth-to-mouth respiration.

4. Describe the Emergency treatment procedure for:
   a) assessing injury
   b) moving the patient
   c) arresting bleeding
   d) completing Workers' Compensation Board forms.

5. Explain the methods of treating various burns and quenching a fire on a victim.

6. Basic C.P.R.

F. Mathematics .....6 hours

1. Fractions (120104a)

Outcome: Solve problems involving fractions

1. Identify key terms and concepts used in working with fractions.
2. Change fractions to a common denominator.
3. Solve problems using whole numbers and fractions.
4. Solve problems using whole numbers and fractions in practical applications.
5. Solve squares and square roots.

2. Decimals (120104b)

Outcome: ***Solve problems involving decimals***

1. Read and write decimal fractions.
2. Round decimal fractions to specified place values.
3. Convert decimal inches to a fraction with a practical denominator.
4. Convert decimal feet to feet and inches with a practical denominator.
5. Convert fractions to decimals.
6. Add and subtract decimal fractions.
7. Multiply and divide decimal fractions.

3. Metric and Imperial Measurement (120104d)

Outcome: ***Solve problems involving Metric and Imperial measure.***

1. Identify commonly used metric units of measurement.
2. Convert between units of measurement.
3. Convert imperial units: feet to inches, square inches to square feet, and cubic measures to gallons.

SECTION TWO:..... BASIC RIGGING ..... 36 HOURS

A. Ropes ..... 28 Hours

1. Define and describe fibre ropes.
   a) Define lays of fibre ropes.
   b) Describe why a certain fibre would be used.
   c) List factors and formulas for fibre ropes.
   d) Care of and material designation.
2. Define and describe synthetic ropes.
   a) Describe types of synthetic ropes why and when used.
   b) Explain formulas for different types of synthetic ropes.
   c) Explain proper methods of care and handling.
3. Define and describe wire ropes
   a) List the types of steel for wire ropes.
   b) List and explain:
      i) four basic types of lays
      ii) advantages of lays
      iii) available type of core
      iv) where cores are used.
   c) Describe the four basic classifications of wire ropes.
   d) Explain working load limits (W.L.L.) and when a wire is unsafe.
   e) Material designation and care.
4. Define and describe working load limits (W.L.L.) formulas and factors.
5. Identify and describe uses of the following knots:
   a) bowline
   b) self-centering bowline
   c) running bowline
   d) clove hitch

e) half hitch
f) rolling hitch
g) reef (square) knot
h) single and double sheet bend
i) timbre knot
j) triple sliding hitch.

6. Define and describe material handling:
   a) hooks clips and shackles
   b) wire rope
   c) chain
   d) wire rope clips, types and methods of application
   e) methods of application.

7. Demonstrate slings and hitches used for preparing and lifting materials.

8. Tie knots and hitches and be aware of load limits.

9. Demonstrate proper use of slings and tag lines.

10. Demonstrate proper use and location of sling configurations on loads for lifting:
    a) smooth heavy loads
    b) long flexible loads
    c) off balance loads
    d) heavy fragile units.

11. Splice fibre and nylon ropes:
    a) short splice
    b) eye with side splice
    c) crown knot and back splice.

12. Test knots and splices.

B. Lifting Devices..... 4 Hours

1. List and describe Mobile cranes:
   a) types of mobile cranes
   b) parts of a mobile crane
   c) parts of a crawler
   d) safe operating and working practices.

2. Demonstrate uses and safe working practices for:
   a) air hoists
   b) come along
   c) wire rope pullers (tirfor)
   d) chainfalls.

C. Signals ..... 4 Hours

1. List and demonstrate signals used for moving equipment and hoisting.

2. Describe methods and precautions in using hand signals.

3. Describe and demonstrate voice communications:
   a) radio (2 way and walkie talkie)
   b) intercom (station to station).

4. Describe precautions used in voice communication.

SECTION THREE: .....TOOLS, CUTTING AND WELDING..... 62 HOURS

The welding instruction under this section shall not be to the level of a proficient and skilled Welder. The intent is to train the potential apprentices to a level where they may operate the required equipment in a safe manner, and perform such operations of metal cutting and welding as to make temporary attachment of component parts, prior to the finish welding required by a certified Welder.

A. Tools..... 22 Hours

1. Identify, illustrate or describe the safe operation and maintenance of the following hand tools:
   - a) spirit level
   - b) plumb bob
   - c) hammers
   - d) chisels
     - i) sharpening
     - ii) removal of mushroomed or fractured head
   - e) screw drivers
   - f) pliers
   - g) clamps
   - h) bolt cutters
   - i) hacksaws
   - j) files
   - k) punches and pins
     - i) connecting bar
     - ii) bull pins
     - iii) ine up bars (drift pins)
     - iv) centre punch
     - v) prick punch
   - l) various types of squares
   - m) scribers
   - n) dividers
   - o) chalk line
   - p) vises
   - q) trammel points
   - r) measuring tools.
2. Recognize safety hazards related to general shop safety.
3. Perform all operations in a safe manner in accordance with the Health and Safety Act and the rules and regulations of specific facilities.
4. Identify the following wrenches:
   - a) structural offset (spud wrench)
   - b) sockets and attendant drives
   - c) adjustable
   - d) combination
   - e) open end
   - f) box end
   - g) set screw (Allen)
   - h) torque
   - i) pipe.
5. Identify, illustrate or describe the safe operation and maintenance of the following power and pneumatic tools:
   - a) hand drills
   - b) electric grinders
   - c) air grinders
   - d) pedestal grinders
   - e) pneumatic chipping hammers.
6. Safely and efficiently operate pneumatic (air) and/or electrically powered portable and stationary drilling equipment.

7. Identify and use twist drills.

8. Operate and maintain reaming equipment.

9. Use and maintain threading equipment for the production of internal and external threads.

10. Use a disc grinder to safely:
    a) clean torch-cut edges
    b) remove tacks/scabs
    c) cut off
    d) wire brush (remove layers of paint, rust, etc.)
    e) sand.

11. Mount grinder wheels on a pedestal and portable grinder.

12. Perform the following operations using a grinder:
    a) grind carbon steel of various shapes to remove metal, scale, slag and burrs
    b) regrind chisels, punches, screw drivers and drifts to the correct size and geometry
    c) buff surfaces.

B. Flame Cutting ..... 20 Hours

1. Identify and describe oxy fuel cutting equipment.
    a) Describe the construction of oxygen and acetylene and other fuel gas cylinders.
    b) Describe the different sizes of cylinders.
    c) Explain the procedure for handling, transporting and storing cylinders.
    d) State the procedure for handling faulty cylinders.
    e) Explain the procedure for filling cylinders.
    f) Explain the construction and purpose of a manifold system.
    g) Identify and select correct fuel gases for manual and automatic flame cutting of carbon steel.

2. Identify and describe regulators.
    a) Describe the purpose of a regulator.
    b) Describe the basic construction and pressures involved for a single stage and double stage regulator.
    c) Demonstrate the correct adjustments and balancing of regulators.

3. Identify and describe hoses.
    a) Explain the construction of hoses.
    b) Identify hoses and fittings.
    c) State the procedure for the repair and maintenance of hoses.

4. Identify and describe oxy-fuel tips.
    a) Describe the design and construction of cutting tips.
    b) Explain the operating principles of a cutting tip.

5. Describe and demonstrate:
    a) care and maintenance of tips
    b) correct selection of tips.

6. Explain and demonstrate setting-up of oxy-fuel equipment.
    a) Explain and demonstrate the correct placement and securing of cylinders.
    b) Explain and demonstrate the clearing and checking of cylinder valves.
    c) Attach regulators safely and correctly.
    d) Correct selection and installation of flashback arrestors.
    e) Attach correctly the barrel and tip.
    f) Explain the correct procedure in checking for leaks.
    g) Check to assure that the regulators were not used for any other purpose than for what they were intended.
    h) Demonstrate safe set-up procedures.

7. Explain and demonstrate pressures and flame adjustments.
    a) Explain and demonstrate the correct regulator adjustments and balancing procedures.
    b) List the reasons for backfires and flashbacks.
    c) Define flame propagation.
    d) Ignite the torch using the recommended striker.

e) Explain and demonstrate the different types of flames and uses.
f) List and demonstrate the acceptable shutting down procedure.

8. Explain and demonstrate fire prevention and controls.
   a) Identify the types of fire extinguishers available and where used.
   b) Define hazardous areas in construction.
   c) Describe how to prevent fires.

9. Perform manual cutting on material of various thickness:
   a) straight line and bevel cutting on plate steel
   b) cuts on various structural steel shapes
   c) circle cutting
   d) hole piercing
   e) radial cutting.

10. Describe expansion and contraction.
    a) Describe how to control expansion, contraction and distortion resulting from, welding and cutting.
    b) Identify and describe forces resulting from expansion and contraction for the straightening or bending of structural members.

C. Electric Arc Welding ..... 20 Hours

1. Define and explain basic electricity:
   a) open circuit voltage
   b) arc voltage
   c) alternating current and direct current
   d) resistance
   e) duty cycle
   f) reverse and straight polarity
   g) heat distribution using reverse or straight polarity
   h) voltage loss.

2. Describe arc welding machines:
   a) basic components and operation of an alternating current transformer
   b) basic components and operation of AC-DC rectifier
   c) basic component s and operation of an AC and DC generator
   d) mulit-process inverter welding power source
   e) advantages and disadvantages of the various types of welding machines.

3. Explain the day to day maintenance required for welding machines.

4. Describe the accessories for welding machines:
   a) cable construction
   b) cable sizing
   c) various types of electrode holders and explain the maintenance required
   d) cable lugs, quick connectors and ground clamps.

5. Describe the controls on a welding machine and the relation to the different voltage and amperage settings.

6. Explain the numerical definitions of electrodes.

7. Describe the following safety equipment:
   a) Describe and wear proper welding apparel.
   b) State the use of protective screens.
   c) Describe a welding helmet and illustrate the proper placement of lenses.
   d) Describe and illustrate safe housekeeping practices.
   e) List the rays involved with welding and the effects associated with these rays.
   f) Describe the procedures to protect oneself and the general public from harmful rays.
   g) List the reasons for grounding of electrical equipment.

8. Demonstrate the ability to weld stringer beads on available mild steel in the flat position using E6010 or E6011 filler material.

9. Demonstrate the ability to weld lap welds on 1/4" (6 mm) mild steel in the flat and horizontal positions using E6010 and E7018 filler material.
10. Demonstrate the ability to weld tee welds on available mild steel in the flat and horizontal position using E6010 and E7018 filler material.
11. Demonstrate the ability to weld a corner joint using E6010 or E7018 filler material.
12. Demonstrate acceptable welding procedures to prevent distortion, etc. for all the joints.

SECTION FOUR: ..... MATERIALS KNOWLEDGE ..... 44 HOURS

A. Metallurgy ..... 10 Hours

1. List the six elements that are always present in steel.
2. Describe the special significance's of carbon in steel.
3. Describe the function of the following elements in steel:
   a carbon
   b) manganese
   c) sulphur
   d) silicon
   e) iron
   f) phosphorus.
4. Describe the effects of carbon and the other elements on the:
   a) physical properties of steel
   b) weld ability of steel.
5. Differentiate between ferrous and non-ferrous metals.
6. Describe the operation of a blast furnace and production of pig iron.
7. Describe the production of cast iron in the Cupola furnaces and the uses of cast iron.
8. Describe the production of carbon steel, alloy steel and stainless steel with reference to the following furnaces in which they are produced:
   a) basic oxygen furnaces
   b) open hearth furnaces
   c) electric furnaces
   d) induction furnaces
   e) vacuum furnaces.
9. Describe the following steels:
   a) killed steel
   b) semi-killed steel
   c) rimmed steel
   d) cast steel.
10. Define the following mechanical properties of plain carbon steel:
    a) stress
    b) strain
    c) elasticity
    d) ductility
    e) toughness
    f) yield point
    g) yield strength
    h) tensile strength
    i) compression strength
    j) elastic limit
    k) brittleness
    l) malleability

m) impact strength
n) elongation
o) torsion strength.

11. Define the following physical properties of plain carbon steel:
    a) colour
    b) melting point
    c) density
    d) weight density
    e) heat and electrical conductivity
    f) specific heat
    g) corrosion resistance.
12. Name the four basic types of carbon steel.
13. Name the five basic types of steels.
14. Describe how the amount of carbon in ferrous material determines whether a material is steel or a cast iron.
15. Explain how low-alloy, high-tensile steels differ from low carbon steels.
16. Determine the main advantage of low-alloy steel.
17. Describe the significance's of AISI steel numbers.
18. Describe the applications of different types of steel for a specific use.

B. Basic Materials ..... 20 Hours

1. Identify all structural shapes by their respective designations (old and new).
2. Explain specific parts of structural shapes as per the designations.
3. Explain the meaning of nominal dimensions.
4. Explain the information, which must be given when ordering wide flange beams.
5. Explain the meaning of the terms camber and sweep.
6. Identify the following structural shapes:
    a) HSS 101.6 x 101.6 x 7.95
    b) W610 x 113
    c) MC 18 x 42.7
    d) S12 x 35.
7. Define the classification of a steel plate with reference to thickness and width.
8. Describe the following designations of a carbon steel plate:
    a) ASTM A-36 A-283 A-285 A-515 A-516
    b) CSA G40.20/21M Standard
    c) AISI System.
9. Explain the purpose and applications of clad steel and other cladding materials.
10. Identify and select welded bar gratings used for stairways and platforms.
11. Identify and select an expanded mesh and expanded mesh grating by its standard sizing.
12. Identify and differentiate the designation as applied for pipe and tube.
13. Describe the pipe schedules with reference to the old and new designation.
14. Differentiate between the imperial and metric designation of pipe.
15. Explain the difference between material designations given as ASTM A53 and ASTM A120.
16. Perform pipe cutting to size using a pipe cutter and/or oxyfuel cutting process.
17. Perform cutting/threading of pipe using manual and mechanical process.

18. Identify the following standard designation:
    a) 2-NPT
    b) 3-8NPS.

19. Describe fixed and aligning threaded fasteners.

20. Interpret nut and bolt markings to determine physical properties and type of material.

21. Describe and select the bolt grading as designated by SAE and ASTM.

22. Identify the following standard designations:
    a) standard M20 x 2.5
    b) standard bolt $^{3}/_{8}$ - 16NC
    c) standard bolt ASTM A325M
    d) standard bolt ASTM A490.

23. Determine the bolt threads length for bolts and screws up to 6 inches in length.

24. Determine the wrench sizes with related reference to the bolt major diameter.

25. Define bolts, studs and screws.

26. Describe the differences between American Standard Unified Thread and metric thread.

27. Identify the following standard thread:
    a) $^{9}/_{16}$ - 18 UNF-2B
    b) $1^{3}/_{4}$ - 15 UN-2A
    c) M30 X 3.

28. Identify the pipe fittings listed and describe their function:
    a) nozzles
    b) couplings
    c) tees
    d) elbows
    e) flanges (including slip-on and welding neck)
    f) blanking plates
    g) plugs
    h) valves.

29. List the pressure ratings used for forged steel flanges.

30. Identify the following standard designations:
    a) 4"-RFWN/RFLWN-300#
    b) 3"-S.O.F.-600#
    c) 90°-2"-LRE.

31. Explain the meaning of a specification given as short radius elbow.

32. Name the valve used to prevent backflow.

C. Trade Related Components..... 16 Hours

1. Identify the pressure vessel components listed and describe their functions:
    a) heads
    b) man ways
    c) davits
    d) trays
    e) domes
    f) hand holes
    g) repads
    h) ductwork
    i) demisters
    j) vortex breakers
    k) catwalks and ladders.

2. Determine the working function of the following:
   a) vortex breaker
   b) demister
   c) repad
   d) plug.
3. Define the difference between the elliptical, dished and hemispherical pressure vessel heads.
4. Define mounting of a Davit for both vertical and horizontal opening.
5. Describe the shapes and minimum standard dimensions of hand hole openings.
6. Determine the minimum diameter used for a circular manhole opening.
7. Determine the use of a steam-dome and tray fittings.

FIRST PERIOD TECHNICAL TRAINING
BOILERMAKER TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS COURSE THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: .....TOOLS, CUTTING AND WELDING..... 64 HOURS

A. Instruments..... 4 Hours

1. Set up transit and tripod including.
   a) connecting transit to tripod
   b) setting up over a given point
   c) leveling
   d) focusing.
2. Use a transit to measure:
   a) elevation
   b) vertical deviation
   c) angular deviation (triangulate).
3. Demonstrate and transfer elevation points using a water level.
4. Demonstrate the skills and abilities in precision measuring using a micrometer (Metric and Imperial).

B. Power Tools (Electric and Pneumatic) ..... 6 Hours

1. Demonstrate the proper and safe use of the following portable power tools:
   a) drills and reamers
   b) tube expanders (identification only)
   c) impacts (wrenches and hammer drills)
   d) pipe threading and cutting equipment.

C. Shop Equipment..... 8 Hours

1. Describe the types of drilling machines.
2. List and describe set-up procedures for drilling machines.
3. Identify and describe drills and drilling tools.
4. Describe drill bit geometry and its sharpening procedures.
5. Determine drilling speeds and feeds.
6. Sharpen drill bits.
7. Set up a drill press and drill multi-diameter holes from $^{1}/_{8}$" to 2" to an accuracy of $^{1}/_{32}$".
8. Describe how to set up power rolls for the following operations:
   a) form a full cylinder
   b) form a partial cylinder
   c) form a cone (reducer)
   d) form a partial and full ring.
9. Calculate metal length before forming, including:
   a) bend allowance
   b) flat sections
   c) seam allowance, e.g. (root opening).

10. Describe how to perform the following operations on a shearing and punching machine safely and correctly:
    a) set up and punch holes in plate, angles, channels and I-beams
    b) shear angles at 45° and 90° with heel inside and outside
    c) shear flat bar, rounds and square bar
    d) notch and cope plate and structural shapes
    e) cut to an accuracy of $^{1}/_{16}$" for length and within 2° for angle cuts.

11. Describe how to set up a power brake press for the following operations:
    a) form 90 degree bends
    b) form oblique angle bends
    c) form a half cylinder
    d) form a half cone (reducer)
    e) form a partial section square to rotated square
    f) form a partial section of square to round.

12. Determine the correct methods of positioning dies for specific operations.

13. Describe the following power saws:
    a) horizontal and vertical band saws
    b) power hack saws
    c) cold saws.

D. Metallurgy ..... 14 Hours

The areas under this section shall be kept at a level of reasonable understanding by the apprentice and shall be of useful knowledge readily applicable to their work. The intent is not to advance to a metallurgist status but rather acquaint the apprentice with knowledge applicable to a working understanding of metal properties.

1. List the basic mechanical and physical properties of metals.

2. Identify the following metals:
    a) white cast iron
    b) gray cast iron
    c) low carbon steel
    d) high carbon steel
    e) chromium-nickel steel (stainless)
    f) high manganese steel
    g) nickel
    h) aluminum.

3. Determine the hardness of metal by using a file and compare to the Brinnell hardness scale.

4. Describe how welding processes (heating) influence steel structures.

5. Describe how heat from welding causes:
    a) residual stresses
    b) structural stresses.

6. Describe methods of preventing or reducing distortion.

7. Describe methods of controlling distortion by applying the correct welding procedures and preheat.

8. Describe methods of correcting distortion including:
    a) peening
    b) grooving and re-welding
    c) straightening
    d) clamping and stress relieving
    e) welding on opposite side
    f) local heating, etc.

9. Effect of alloys on the oxidization (cutting) action.

10. Determine the effect of carbon in its relationship to the weldability and flame cutting of steel.

11. Determine the effect of alloys in their relationship to the weldability and cutting action in steels.

12. Explain the principle of heat straightening methods.
13. Explain the significance of cold working metals.
14. List advantages of hot working metals.
15. Describe mechanical and physical effects of metals after hot and cold forming.

E. Cutting, Welding and Related Processes..... 32 Hours

The welding instruction under this section shall not be to the level of a proficient and skilled welder. The intent is to train the apprentice to a level where he may operate the required equipment in a safe manner, and perform such operations of metal cutting and welding as to make temporary attachment of component parts, prior to the finish welding required by a certified welder.

1. Describe heat straightening.
2. Demonstrate techniques of flame straightening on a:
   a) plate
   b) pipe
   c) distorted header
   d) distorted structural member.
3. Describe cutting processes involved in cutting alloy steels and non-ferrous metals plasma-arc and water jet cutting.
4. Explain correct cutting techniques and common cutting faults.
5. Perform flame cutting skills involving radial cuts.
6. Demonstrate flame-cutting skills on:
   a) pressure vessel heads
   b) pressure vessel shells
   c) structural shapes.
7. Interpret weld joint preparations, joint edge preparation and joint tolerances from drawings.
8. Determine if metal conditions require special cleaning methods.
9. Explain the manufacturing specification control for arc welding electrodes.
10. List the functions of coating for arc welding electrodes.
11. List the functions of the slag for arc welding electrodes.
12. Explain the effects of alloy additions to the coating for arc welding electrodes.
13. Explain static and dynamic loading for arc welding electrodes.
14. Explain the proper storage of low hydrogen electrodes.
15. Explain the reasons for selecting a welding machine for a specific task.
16. Explain the consideration to be taken when installing an arc-welding machine in a shop environment.
18. Recognize these other welding processes, GTAW, GMAW and thermal spray.
19. Demonstrate the set up arc air gouging equipment correctly and safely without causing damage to the equipment and its accessories.
20. Determine for each welding operation the required:
   a) joint spacing
   b) holding or clamping devices
   c) number and spacing of tack welds
   d) pre-setting/distortion allowances of joint member current type, polarity and voltage
   e) correct welding procedures.
21. Interpret welding symbols as standardised by the American Welding Society:
   a) parts
   b) materials preparation
   c) weld types
   d) dimensioning
   e) position

f) execution (field or shop)
g) finish (flush, chip or grind).

22. Demonstrate the ability to weld in the vertical and horizontal positions using E6010 or E6011 filler material.

23. Demonstrate the ability to weld lap welds on ¼" (6 mm) mild steel in the vertical and horizontal positions using E6010 and E7018 filler material.

24. Demonstrate the ability to weld a flat and horizontal butt welds on ¼" (6 mm) mild steel using E6010 or E7018 filler material.

SECTION TWO:..... DRAWING INTERPRETATION ..... 84 HOURS

This section consists of lectures and supporting shop practices on the progressive preparation of materials in the proper sequence to successfully fabricate a small project beginning with the print and selection of materials to the finished project.

A. Basic Drafting..... 27 Hours

Interpretation and correlation of information found on multi-sheet complex prints, including material, identification on parts, orientation and layout of structure or parts of a structure utilizing to the fullest actual working prints on vessels, tanks, precipitators and boilers.

1. Use minimum drafting equipment to assist in developing principles of drawing construction.

2. Read drawings, prints or sketches and properly fold and protect them for immediate and future use.

3. Read and interpret the proper use of signs, symbols and abbreviations as may be required.

4. Identify line types and uses, analyse the proper lettering and where it is used relative to the associated terminology.

5. Identify the correct placement of dimensions applying the unidirectional system.

6. Recognize the style of lettering with reference to sizing and placement.

7. Describe the following parts of a drawing:
   a) title block
   b) scale
   c) contract numbers
   d) section on same and different sheets
   e) revisions
   f) parts and identification marking.

8. Give the main reason for a sectional view.

9. Explain a cutting plane line.

10. Explain a section line.

11. List three types of sections.

12. List two requirements for a multi-view projection.

13. Give examples of parts that need one or two views only.

14. State the difference between primary and secondary auxiliary views.

15. Define the right and left hand views.

16. Name two advantages for using partial views.

17. Define the principle of orthographic projection.

18. Explain the principle and applications of an isometric projection.

19. Describe materials and techniques used in freehand sketching.

20. Sketch freehand to available materials and techniques used, to convey information to other workmen to produce the subject item, such as small tanks, frames, stands, brackets, etc.

21. Identify the signs, symbols and abbreviations on drawings compiled from standards generally used on the following components:
    a) materials preparation
    b) structural and plate
    c) fired and unfired pressure vessels
    d) tank
    e) heat exchangers
    f) precipitators.

22. Interpret the following basic welding symbols and abbreviations:
    a) weld
    b) supplementary symbols
    c) specifications
    d) groove and weld dimensions
    e) contour
    f) method of finish
    g) single and double breaks in arrow line
    h) standard rules for reading welding symbols
    i) location of symbols on drawings.

23. Communicate weld requirements through use of basic welding symbols.

B. Identification of Pressure Vessels ..... 7 Hours

1. Recognize industries that fall under the "heavy" category.

2. Identify the boilermaker's involvement, safety hazards and safe working procedures in the following heavy industrial sectors:
    a) nuclear generating stations
    b) hydro generating stations
    c) fossil fuel generating stations
    d) oil refineries
    e) pulp and paper mills
    f) steel plants.

3. Identify water tube boilers with reference to the position of tubes and drums.

4. Identify the firetube boiler with respect to the position of a furnace.

5. Explain the working principle of water tube and firetube boilers.

6. Describe the types of fired vessels.

7. Describe shell and tube sheet construction.

8. Identify boiler tubes.

9. Describe the function of a firebox.

10. Explain the purpose of stays.

11. Explain the purpose of buckstays.

12. Describe the scope and limitations of ASME boiler and pressure vessel code.

13. Identify platforms, ladders, walkways and other typical structures related to boilers.

14. Describe the working principle of heat exchanger.

15. State the reason for heat exchanger baffles.

16. Explain heat exchanger sizing and type designation.

17. Describe shell and tube sheet construction.

18. Identify platforms, ladders, walkways and other typical structures related to heat exchangers.

19. Describe the working principle of distillation towers.

20. Identify platforms, ladders, walkways and other typical structures related to distillation towers.
21. Describe the basic types of storage tanks.
22. Identify platforms, ladders, walkways and other typical structures related to tanks.
23. Identify procedures and equipment used in basic tank erection.
24. Explain how to safely and efficiently carry out basic tank erection practices.

C. Introduction to Layout ..... 18 Hours

1. Identify, select and use types of basic measuring, checking and layout tools in terms of:
   a) available types
   b) standard features
   c) design characteristics
   d) maximum obtainable accuracy
   e) applications
   f) correct method of use
   g) correct handling
   h) storage and maintenance procedures
   i) required conditions of use.
2. Perform the following basic geometrical constructions:
   a) construct a line segment equal to a given line segment
   b) construct an angle to a given angle
   c) bisect a given angle, layout 45, 60, 30 degree angles
   d) construct a line perpendicular to a given line through a given point on the line
   e) bisect a given line segment
   f) construct a line perpendicular to a given line through a given point outside the line
   g) construct a line parallel to a given line through a given point
   h) construct a tangent to a given circle through a given point on the circle
   i) divide a line segment into any number of equal parts
   j) circumscribe a circle about a triangle
   k) locate the centre of a given circle
   l) inscribe a circle in a given triangle
   m) construct regular polygons with any number of flats
   n) inscribe and circumscribe regular polygons
   o) layout an angle
   p) inscribe a given radius into right angle, acute angle and obtuse angle turns
   q) bisect a given arc
   r) construct an ellipse using three different methods.
3. Using the parallel line development method, develop a pattern for a rectangular piece of ducting cut at an angle.
4. Using the parallel line development method, develop a pattern for a two-piece 90-degree elbow.

D. Materials Preparation and Assembly ..... 12 Hours

1. Explain and describe the layout procedure for properly marking-up an assembly for:
   a) cutting
   b) braking
   c) shearing
   d) rolling
   e) drilling
   f) punching.
2. Describe the purpose for templates:
   a) materials used to make templates
   b) types of templates.

3. Develop the following templates:
   a) bending (sweep)
   b) marking (gusset plates)
   c) pattern (pipe turns).

4. Describe the procedures for identifying fabricated assemblies:
   a) item numbers
   b) material identification
   c) job and contract numbers
   d) erection sequencing.

E. Basic Mathematics ..... 20 Hours

Mathematics has been determined as being an integral component of the technical training when it is applied in the strictest terms of trade involvement specifically being totally related. Due to the nature of application in the trade of Boilermakers, the mathematics given under this section shall be flexible and applied to the work where feasible.

1. Solve simple arithmetic problems by applying the principles of:
   a) whole numbers
   b) decimal numbers
   c) fractional numbers
   d) mixed numbers.

2. Using linear measurements compute perimeters of the following shapes:
   a) rectangles
   b) squares
   c) triangles
   d) circles.

3. Solve linear measurement problems using the Imperial and Metric measurement systems.
   a) Perform arithmetic operations with length.
   b) Perform arithmetic operations with weights and capacities.
   c) Perform arithmetic operations with volumes.
   d) Express units of area measure.
   e) Express units of volume measure.
   f) Perform combining calculation on practical applications using various units of measure.
   g) Compute conversions from Imperial to Metric and visa versa.

SECTION THREE: ..... GENERAL RIGGING ..... 32 HOURS

A. Wire Rope ..... 12 Hours

1. Identify sizing of hooks, clips and shackles.
2. Name two types of wire rope clips.
3. Use formula to determine the number of clips required.
4. State the differences of shackle pin diameter and size of its bow.
5. Determine the types of loading recommended for shoulderless eyebolts.
6. Calculate the working load limits (WLL) derived from formulas to calculate the WLL for all parts.
7. Define the design significance of grommet slings.
8. Describe the preferred application for a double wrap basket hitch.

9. Determine the centre of gravity for different types of loads such as:
   a) structural members of a different designation
   b) regular plates
   c) irregular shapes of plates
   d) assemblies.

10. Define the choker stress formula.
   a) Apply the W.L.L. into various load and sling configurations.
   b) Use table and charts for slings and general rope hardware.

B. Block and Tackle ..... 20 Hours

1. Demonstrate or describe safe work practices of block and tackle involving reeving techniques:
   a) square
   b) skip
   c) tandem
   d) equalizer sheaves
   e) lacing
   f) reeving of simple and multi-blocks up to 24 parts.

2. Calculate the mechanical advantage of block and tackle systems.

3. Determine the working load limits that can be lifted with a given rigging arrangement.

SECOND PERIOD TECHNICAL TRAINING
BOILERMAKER TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS COURSE THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... MATERIALS AND RELATED KNOWLEDGE ..... 30 HOURS

A. Heat Treatment ..... 10 Hours

1. Describe the forming of steel from the ingot stage to the finished product such as:
   a) plates
   b) sheets
   c) bars
   d) rods
   e) tubes
   f) rails
   g) pipes
   h) structural shapes.
2. Define the following terms:
   a) hot rolled
   b) cold rolled
   c) tempered
   d) annealed
   e) normalized
   f) galvanized.
3. Interpret C.S.A. 40.20/21 standard for structural steel.
4. Interpret the SAE/AISI for a given plain carbon steel to determine its carbon content, method of manufacture and weldability.
5. Interpret the ASTM specification for a given plain carbon steel to determine its strength, usage and weldability.
6. Interpret the AISI system for designating stainless steels Series 200,300 and 400).
7. Identify major sources of heat used for heat treatment:
   a) flame
   b) natural gas and compressed air
   c) annealing furnace or ovens.
8. Identify the three factors which are contingent to proper hardening of steel.
9. List the reasons for tempering some metal after heat treating.
10. Describe procedures for controlling hardness in the heat affected zone of a weld.
11. List three rules which help in determining the need for preheating carbon steel prior to welding.
12. List four advantages in preheating of carbon steel for metal arc welding.
13. Identify effects of various stages of heat treatment:
    a) expanding and shrinking
    b) stress relieving
    c) annealing
    d) normalizing
    e) preheating
    f) post heating.

14. Describe grain structures in terms of:
    a) ferrite
    b) cementite
    c) pearlite
    d) austenite
    e) martensite.

15. Describe normalizing and annealing processes and give reasons for them.

16. Describe post-weld heating as a means to:
    a) relieve stresses
    b) improve toughness
    c) increase strength and durability.

17. Describe stress relieving as a post-weld method to:
    a) reduce residual stresses
    b) improve service life of the weldment.

18. Describe the importance of correct temperatures and correct heating and cooling rates.

19. Describe measures to control and check temperatures during preheating and postweld heating.

20. Describe the influence of the following on the micro-structure of the weld area:
    a) the rate of heating
    b) the time at temperature
    c) the rate of cooling.

B. Related Knowledge ..... 20 Hours

1. Develop a resume for employment purposes.

2. Identify types of work-orders and their content with respect to:
    a) quantity and quality of product
    b) customer I.D.
    c) graphic support
    d) time and material availability
    e) responsibilities.

3. Interpret and explain the technical - administrative procedures related to the following documents:
    a) invoices
    b) purchase orders
    c) shipping and receiving slips
    d) requisition orders
    e) payable, personal and company cheques.

4. Communication on the job.
    a) List two efficient communication media used between management and workers.
    b) Demonstrate effective communication with your co-workers.

5. Project progress reports.
    a) Write brief reports outlining the progress of a fabrication or assembly project.

6. Plant tours (choice of some of the following):
    a) steel fabrication shops (vessel and structural)
    b) rolling mills (available types)
    c) operational job sites (with permitting authority)
    d) foundries (when and where time permits).

7. Guest speakers:
    a) unions
    b) management
    c) Apprenticeship and Trade Certification
    d) production representatives.

8. Define the role and mission of the Labour Union organization.
9. Identify different production environments among local metal fabrication and assembly shops.
10. Assess the capabilities and specialty of machinery and metal working equipment among local enterprises.
11. Identify and describe an erection site at a typical power generating plant.
12. Describe the assembly sequences involving an erection of power boiler as observed during the excursion tour.

SECTION TWO:.....ADVANCED RIGGING..... 52 HOURS

A. Wire Rope Drums ..... 4 Hours

1. Describe and state fleet angles for grooved and smooth drums.
2. Determine the required wire rope drum capacity.
3. Describe and demonstrate spooling procedures.

B. Advanced Block and Tackle ..... 12 Hours

1. Determine the lead line force when the number of parts and load weight including rope size are known.
2. Identify the factors that determine the amount of wire rope needed for a reeving system.
3. Name three types of sheaves, friction bearings and the coefficient of friction expressed in percent.
4. Raise and lower a load using a reeved system.

C. Cranes ..... 12 Hours

1. Identify and describe the following cranes:
   a) hydraulic
   b) conventional
   c) rough terrain
   d) high capacity cranes and new technology.
2. Demonstrate or describe the following terms related to cranes:
   a) general uses
   b) use of tables/load charts
   c) signals
   d) boom assembly and disassembly
   e) components
   f) breakdown for transportation
   g) safety precautions.
3. Name four major types of mobile cranes.
4. Demonstrate the knowledge of signals.
5. Determine the basic procedures for the crane boom installation and removal.
6. List the basic conditions for counterweight installation and removal.
7. Determine the positioning of all pins at boom assembly.
8. Determine the reason for and load reduction when jib is fitted on the boom.
9. Determine in degrees the jib offset allowance in reference to the centreline.
10. List three negative implications when crane is only three degrees out of level.

D. Hoisting and Jacking Equipment..... 10 Hours

1. Safe uses and calculations for hoisting and jacking equipment.
2. Describe the proper use of chain falls, tirfors and come longs.
3. Calculate stress and explain the uses and safety hazards of high lines.
4. Perform rigging, hoisting and jacking operations in a safe and responsible manner in accordance with the Occupational Health and Safety Act and any other applicable regulations.
5. Rig loads safely and correctly for:
   a) straight lifts
   b) drifting
   c) turning.
6. Determine the positioning of tuggers.
7. Determine air pressure requirements tuggers.
8. Determine anchor points tuggers and hoists.
9. Describe safe and secure attachment of blocks to tuggers and hoists.
10. Describe types of hoists.
11. Describe the following jacking systems:
    a) skates, rollers and cribbing
    b) air bags
    c) hydraulic lifts.

E. Scaffolds..... 8 Hours

1. Describe the complete set-up of all scaffolds and needle beams:
   a) set-up.
   b) plank inspection.
   c) plank placing and securing.
   d) ladder.
   e) swingstage scaffolding.
   f) suspended scaffolding.
   g) needle beams.
   h) modular platforms.
2. Describe the safe use of self-propelled work platforms.

F. Rigging Prints..... 2 Hours

1. Interpret from a rigging print the information required to position a crane for any lifting operation.

SECTION THREE: LAYOUT AND FITTING ..... 98 HOURS

A. Mathematics ..... 18 Hours

1. Compute squares and square roots of numbers.
2. Apply square roots calculation in solving right angle triangle problems using Pythagorean Theorem.
3. Compute area of flat planes:
   a) squares
   b) parallelograms
   c) triangles
   d) rectangles
   e) circles
   f) sectors.
4. Compute the surface area of:
   a) regular shaped solids, tanks and cylinders
   b) pyramids and cones
   c) prisms and cylinders
   d) areas, radii, arc length, circumferences, central angles and diameters of circles
   e) altitudes and bases of common polygons
   f) circular sectors and segments
   g) common polygons, given bases and altitudes
   h) more complex figures consisting two or more common polygons.
5. Calculate volume, capacity and weight of:
   a) prisms and cylinders
   b) pyramids and cones
   c) spheres.

B. Drawing Interpretation ..... 24 Hours

1. Demonstrate how to fabricate the following using drawing interpretation skills:
   a) vessels
   b) tanks
   c) boilers
   d) related structures.
2. Demonstrate how to erect vessels, tanks, boilers and related structures from drawing interpretation skills.
3. Interpret structural steel erection drawings.
4. Introduction to computer produced drawings.

C. Layout and Fabricating ..... 30 Hours

1. Read a drawing and describe the component(s) used in the development and fabrication process.
2. List and describe the types, uses and care of plate layout tools.
3. Layout angles to meet the requirements of the fabrication from the drawing.
4. List and describe the abbreviations applicable to plate layout and development.
5. Calculate practical problems on squares, rectangles and circles for transfer to the plate for development and fabrication.
6. Develop a layout using basic geometric constructions on plate.
7. Read a drawing, determine the materials required and layout the pattern on the plate.
8. Develop a layout for the geometric construction of bolt circles, manholes, flanges and ellipses.

9. Layout and fabricate the following:
   a) ladders and platforms
   b) a davit for vertical and horizontal opening
   c) a header
   d) pipe turns and offsets
   e) square ducts
   f) cylinders and cones
   g) pressure vessel shells.

10. Perform radial nozzle installation.

D. Fibreglass Fitting ..... 26 Hours

1. Identify skills required to install fibreglass fittings:
   a) blueprints
   b) drilling
   c) bolting
   d) understanding types of resin
   e) cutting
   f) grinding
   g) laminating glass.

2. Identify and describe the resins and fibreglass materials required to facilitate repairs on round and flat surfaces.

3. Describe the uses of fibreglass in pulp mills, chemical plants and refineries.

4. Describe where boilermakers use fibreglass in tanks, silos, stacks breeching and piping.

5. Define the purpose of the following fibreglass materials:
   a) polyester resins
   b) catalysts
   c) promoters
   d) surfacing veil
   e) mat
   f) woven roving
   g) acetone
   h) methylene chloride
   i) air dry additive.

6. Perform the skills required to safely handle and store the chemicals required to assemble fibreglass pipe.

7. Perform the skills required to facilitate repairs on round and flat surfaces.

8. Describe the following tools and materials used for preparation and assembly
   a) power cutter (skill saw)
   b) power disc sander
   c) extension cords
   d) rags
   e) wax paper (feeler wrapper)
   f) rubber gloves
   g) paper coveralls
   h) face shields
   i) safety goggles.

9. Describe the following measuring equipment:
   a) paper or plastic mixing cups
   b) mixing sticks
   c) plastic bucket graduated for measuring resin
   d) glass for measuring promoters and catalysts
   e) mixing pails.

10. Describe the following lay-up equipment:
    a) 10 mil surfacing veil
    b) 11/2 oz. mat
    c) woven roving.

11. Describe the following procedures or equipment:
    a) tight fitup
    b) sanding
    c) filler
    d) saturate mat
    e) stagger cut lengths
    f) mix resin and catalyst
    g) apply 10 mil surface veil
    h) remove air
    i) sand entire weld
    j) apply resin and air dry mix
    k) heat lamps
    l) application method
    m) hand lay-up
    n) spray lay-up
    o) cutting, fitting and surface preparation
    p) outside joint (structural)
    q) inside joint (liner).

THIRD PERIOD TECHNICAL TRAINING
BOILERMAKER TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS COURSE THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... MATERIALS AND RELATED KNOWLEDGE ..... 30 HOURS

A. Testing of Materials ..... 10 Hours

1. Describe the following types of destructive testing:
   a) tensile test
   b) bend test
   c) impact test.
2. Differentiate between destructive and non-destructive testing of material.
3. Define the ultimate tensile strength.
4. Describe the principle involved in testing the steel toughness.
5. Describe the free-bend test used in weld testing.
6. Describe the following types of Non-destructive testing:
   a) radiographic
   b) ultrasonic
   c) dye penetrate
   d) hydrostatic
   e) vacuum and air.
7. State how a dye penetrate is used in determining the soundness of a weld area.
8. Describe the principle of ultrasonic testing.
9. Perform magnetic particle testing on a defective weld using a magnetic particle-testing unit.
10. Describe applications and limitations of vacuum and air testing.
11. Perform visual inspection on a welded specimen and summarize the results.
12. Explain the principle and scope of radiographic testing.
13. Determine how radiographic inspection will show hidden defects in a weld.

B. Inspection ..... 20 Hours

1. Inspect and interpret material and welds with reference to:
   a) soundness, size and shape
   b) plate thickness and prescribe quality of material
   c) positions of circumferential and longitudinal seams
   d) heads, their opening and reinforcement
   e) skirt, diameters and minimum thickness
   f) base rings and anchor bolt chairs
   g) saddles, welded or shipped loose
   h) shell openings, limitations and reinforcement
   i) internals and removable internals
   j) internal/external piping and flanges
   k) adders, platform and lugs
   l) all fabrication tolerances within limits.

2. Identify the characteristics of acceptable quality of components and parts based on:
   a) code specifications
   b) drawing requirements
   c) general usage.

3. List four factors contingent to production flow in fabrication and assembly of pressure vessels.

4. List three types (stages) of a product quality control.

5. Describe two methods that can be used to improve production and productivity of fabrication processes.

6. Describe the preparation for shipment of a final product with respect to the following components:
   a) inside and outside of the vessel
   b) finished surfaces
   c) flanged openings
   d) threaded openings
   e) bolts and nuts
   f) small parts and loose internals
   g) loading and securing the vessel
   h) markings and special instructions.

SECTION TWO:..... LAYOUT AND FITTING..... 50 HOURS

A. Layout ..... 30 Hours

1. Interpret drawings to layout and fabricate square, round and elliptical holes.

2. Determine roll and brake capacity and allowances and proper direction to roll or bend.

3. Demonstrate power rolling equipment and recognize how to perform the following operations:
   a) form a partial cylinder
   b) form a partial cone
   c) form a full ring
   d) form a full cylinder and frustum of a cone.

4. Develop templates using geometry, parallel lines, radial lines and triangulation using these templates to layout on plate in the proper sequence by setting square and to required angles and supporting same.

5. Develop patterns for various objects made in the shop using the triangulation method:
   a) oblique pyramid
   b) oblique cone
   c) square to round transition
   d) round to square transition
   e) square to rotated square transition
   f) square to round oblique transition.

B. Fitting ..... 20 Hours

1. Fit pipes and shell section components from drawings by using the proper layout procedure, assemble with the proper tools and fitting aids, know the misalignment allowances, fit shells to shells, heads to heads, layout on shells, heads, repads and nozzles, fit tray rings and downcomer bars, ladder and platform clips, davits, skirts or bases and all other miscellaneous components.

2. Develop patterns for various objects fabricated in the shop using the radial development method:
   a) pyramidal shapes (hopper)
   b) hopper cut at an angle
   c) variety of right circular cones with different upper and lower shapes.

3. Describe how to fit up circumferential seams.

4. Describe how to fit up and align longitudinal seams.

5. Describe how to fit up shell to shell of equal thickness.
6. Describe how to fit up shell to shell of unequal thickness.
7. Describe how to fit up shell to head.
8. Describe how to fit up reinforcing pads to nozzle and shell.
9. Describe how to fit up repads to heads.
10. Describe how to layout and fit up nozzle, coupling and structural components to the shell and head.
11. Describe how to layout a vessel base ring and skirt openings.
12. Describe how to assemble and fit up absorbing tower trays and down comers.
13. Describe how to fabricate and assemble davit parts for vertical and horizontal openings including hinges.
14. Describe how to install a tangential nozzle.

SECTION THREE: .....TRADE RELATED COMPONENTS.....100 HOURS

Special emphasis should be placed on procedures used in installation, shut-downs and emergency repairs and recognition of the time limitations of shut-downs and emergency repairs.

A. Boilers ..... 30 Hours

The boiler print course should be complemented by boiler components and erection procedure practice, where suitable shop equipment and time will permit.

1. Describe rigging and welding procedures for the following Boiler components:
   a) structure
   b) drums
   c) headers
   d) tubes
   e) platens
   f) buck stays
   g) casing
   h) fire door
   i) super heater elements
   j) reheat elements
   k) economiser
   l) air heater
   m) deaerator
   n) water treatment.
2. Describe the working operation of a water tube boiler.
3. Describe boiler tube installation procedures, for the following:
   a) preparation of tube sheets
   b) tube sizes
   c) tube material
   d) expanding limits
   e) fit up of tube
   f) tube bending
   g) seal welding
   h) tack tubes
   i) self feed expander
   j) retractive
   k) lubrication
   l) mandrels
   m) over rolling
   n) under rolling
   o) micrometers and gauges

p) belling
q) ferrules
r) repairing leaks
s) testing.

4. Identify the following auxillary boiler equipment, steam generator components, state their function, material origin, and any special features:
   a) drums and headers
   b) platen and buckstays
   c) super heater and reheater
   d) economiser and air heater
   e) deaerator
   f) air ducts
   g) stacks and breaching
   h) condenser
   i) fans, I.D. and F.D.
   j) intake and discharge lines
   k) precipitators
   l) wet and dry electrostatic precipitors
   m) stokers
   n) burners
   o) bag houses
   p) scrubbers
   q) selective catayalic reducers
   r) air cooled condensers (ACC)
   s) testing and codes.

5. Identify boiler tube designation with respect to sizing and quality of material.

6. Describe the function of tubes in various arrangements.

7. Identify the two basic methods used to fabricate tubes.

8. Determine the tube bending procedures with reference to:
   a) long radius bends
   b) short radius bends
   c) very short radius bends (super heater section)
   d) using field type equipment.

9. List methods of tube attachments.

10. Describe basic procedures for watertube boiler tube installation including the preparation and cleaning process.

11. Identify and describe standard propulsive tube expander.

12. Identify and describe retractive expander.

13. Explain the principle of tube expansion including the theory involving the flow of tube material.

14. Describe the usual adopted tube expanding procedures stating the upper and lower limitations.

15. List tube expanding, checking and measuring devices in use.

16. Define the purpose of tack tubes.

17. Identify and explain the following additional operations involving tube forming or welding:
   a) expanded and beaded
   c) beaded and seal welded
   d) expanded and welded
   e) expanded and bevel welded
   f) expanded by expanded and flared
   b) prosser method
   g) expanded with ferrules.

18. Explain the following terms which are associated with the tube hole arrangement:
    a) circumferential pitch
    b) alignment
    c) pitch
    d) removal space
    e) longitudinal pitch
    f) diagonal pitch.

19. Set-up and perform tube rolling operations.

20. Set-up and perform tube bending operations.

21. Set-up and perform tube installations and tube removals.

22. Describe and perform procedures for tube repair(s):
    a) knowledge of Boiler code and local regulations
    b) identify tube(s) to be repaired
    c) mark tube(s) for cutting
    d) cut out tube(s)
    e) prevent tube blockage
    f) prepare existing tube ends
    g) prepare replacement tube(s)
    h) fit and tack replacement tube(s)
    i) variation of tube repair
    j) window weld
    k) appropriate preparation for different wall thickness.

B. Tanks ..... 30 Hours

The tank print course should be complemented by tank components and erection procedure practice, where suitable shop equipment and time will permit.

1. Know and identify the different types of materials described under this topic:
    a) carbon steel
    b) alloy steel
    c) nonferrous metals
    d) gauges and plates
    e) mesh and screen.

2. Determine the tank steel plate standard used for shells and decks with reference to the A.P.I. specification.

3. Distinguish between the scope of A.P.I.650 and A.P.I.620 standard and tank repair code A.P.I. 651 or 653.

4. Prepare materials for welding by proper preparation, spacing, alignment and safety.

5. Identify the type of welding and joint preparation for a tank bottom, shell and deck.

6. Determine the following type of welding on, roof to top angle, bottom to shell, shell to top angle.

7. State the rule for vertical and horizontal seam openings.

8. Perform the fit up and alignment of tank horizontal and vertical seams.

9. Describe the differences of the following types of tanks:
    a) vertical and horizontal (cylindrical)
    b) closed top or open (vented)
    c) elevated spheres
    d) penstock
    e) scroll cases.

10. Identify the typical horizontal, vertical and spherical type of tank settings.

11. State the difference between the penstock and scroll or spiral casing.

12. Describe the environmental and economical advantages of closed top tank design.

13. Describe the difference between a cone roof, hemispherical roof and a floating roof.

14. Explain the following terms associated with floating roofs:
    a) hard top floater
    b) pontoon floater
    c) double-deck floater.

15. Describe the difference between a flat (butt or lap) floor, orange peel, floor and a hopper floor.

16. Describe the basic steps in laying out flat tank floor.

17. Describe the procedures involving minimum flat lap welding and flushing lapped plates.

18. Describe the uses of balance beams, knee braces, key plates, clamps, dogs and wedges as used in tank construction.

19. Perform fit up using key plates, leaf springs, finger bars and pins, wedges and dogs, clamps and nuts.

20. Layout key plate lugs on the shell plate sections prior to being set up in position.

21. Layout shell plate with reference to the vertical seams staggering.

22. Layout and erect typical tank scaffolding.

23. Describe the complete tank erection procedures of the components listed:
    a) site preparation
    b) floor
    c) first shell ring
    d) succeeding rings
    e) top angle
    f) roof supports and roof
    g) ladders, stairways and platforms, etc.
    h) shell fittings
    i) testing and repairs if required.

24. State the general condition of tank foundation and list negative effects encountered during an erection due to uneven surfaces.

25. Perform layout and fit up at a typical flat bottom lap joint.

26. Layout and erect the first shell ring.

27. Erect and properly space the succeeding rings.

28. Perform layout and fit up of the top angle.

29. Layout and fit up a conical self supported roof.

30. Layout and fit up shell, roof and bottom openings for a given:
    a) manway
    b) cleanout
    c) water or fluid drawoff elbow
    d) drawoff sump
    e) inlet outlet
    f) overflow venting
    g) walkway, stairway and ladders.

31. Describe how to test tank bottom, shell and roof using one or two of the approved methods of testing.

32. Inspect all seams for unwelded spots and faulty welding.

33. Differentiate inspection requirement for large and small tanks specified by the API.650 and API.620.

34. Describe cathodic protection.

C. Condensers and Exchangers ..... 30 Hours.

The condensers and exchangers print course should be complemented by erection and maintenance practice, where suitable shop equipment and time will permit.

1. Identify different types of exchangers as listed below:
   a) single pass
   b) multi pass
   c) split flow
   d) double split flow
   e) divided flow
   f) cross flow
   g) kettle type reboiler.

2. Identify different design of heat exchangers as classified by the T.E.M.A. with reference to:
   a) front stationary head
   b) rear head.

3. Identify different types of tubes as listed:
   a) expanded
   b) welded
   c) materials.

4. Identify heat exchanger and condenser tubes with respect to:
   a) types of material and job application
   b) material designation
   c) standard sizes and gauges
   d) tolerances
   e) fabrication and bending procedures.

5. Identify the different shells as listed below.
   a) Identify types of baffles, their function and installation procedures.
   b) Identify four different tube sheet layouts and state their preference of application.
   c) Determine the pitch for a triangular tube sheet layout.
   d) Identify the various qualities of material for different applications.

6 Explain the following types of heads:
   a) channel and removable cover
   b) bonnet
   c) channel integral with tube sheet
   d) pull through and floating head
   e) outside packed floating head.

7. Describe tube expanding procedures for condensers and exchangers:
   a) tube sheet layout
   b) number of tubes
   c) type of metals
   d) length of tubes
   e) diameter of tube (O.D.)
   f) all thickness of tubes
   g) tube sheet or header thickness
   h) expansion required
   i) lubrication.

8. List the basic steps associated with tube installation.

9. State the recommended tube expansion sequences with reference to tube sheet layout, its area and shape.

10. Measure the inside diameter of a tube.

11. Calculate the expanded diameter of a tube.

12. Determine the percentage wall reduction as recommended for ferrous and non-ferrous materials.

13. List recommended lubricants.

14. Identify the optimum length of expanded seat.

15. Explain the reason for grooved seats.

16. Identify the factors affecting the quality of an expanded joint with reference to:
    a) surface of hole
    b) roundness of hole
    c) cleanliness of hole
    d) expansion past the inner edge of tube sheet
    e) overheating
    f) roller speed
    g) mechanical properties of tube and tube sheet
    h) lubrication or lack of it
    i) over expansion and indication of it.

17. Describe expanding equipment listed to install condenser and exchanger tubes:
    a) compressor
    b) air motor
    c) electric motor
    d) tube and mills
    e) tube expanders
    f) fly cutters
    g) tube cutters
    h) tube cleaning
    i) tube removal tools
    j) micrometers
    k) torque wrench.

19. Describe the specific characteristics of air and electrically powered expander drives including the accessories and controls.

20. Describe tube end milling equipment, set up and techniques employed.

21. Determine the reason for the mandrel conical shape.

22. State the purpose of bell roll(s).

23. Identify the propulsive type of expander.

24. Demonstrate the ability to identify and use the following tools:
    a) fly and tube cutters
    b) tube removal tools
    c) torque wrench
    d) micrometers and gauges.

25. Explain the principle involving explosive tube expansions.

26. Perform tube expansions into tube sheet using electrical and air powered expander drives.

27. Perform tube flaring using flaring tools.

28. Describe the procedure to locate, remove, replace and test for defects when making repairs to exchangers.

29. Inspect for tube leakage involving removal of:
    a) cover or bonnet
    b) shell cover and floating head
    c) channel.

30. Perform hydrostatic test of shell using test ring (on types S & T).

31. Remove the tube bundle, inspect and replace it.

32. Assemble the heat exchanger and perform proper stud tightening procedures.

33. Perform tube plug installation and identify plug material compatibility related to the tube.

34. Identify the possible safety features associated with heat exchangers, testing, inspections and repairs.

D. Introduction to Other Heavy Industry ..... 10 Hours

1. Identify practices used in the erection of penstocks and surge tanks.
2. Identify the function of all components needed for the erection of penstocks and surge tanks:
   a) footings
   b) tie bars
   c) spiders
   d) tie straps.
3. Describe how nuclear generating works.
4. Identify special procedures used when working on nuclear plants and components:
   a) problems specific to nuclear plants
   b) material which cannot be used
   c) difference in metals
   d) quality control
   e) special materials
   f) radiation
   g) radiation hazards
   h) weldment requirements
   i) expanding requirements.

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